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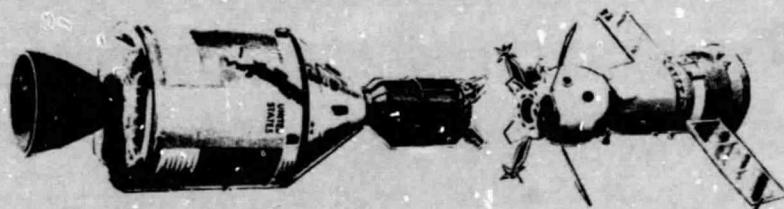
# USSR Space Life Sciences Digest

A QUARTERLY REVIEW

Volume 1, Number 3



*Prepared for the*  
**Life Sciences Division**  
**National Aeronautics and Space Administration**  
**Washington, D.C. 20546**



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*Contract NASSW-3223*

**September 1980**

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## INTRODUCTION

Soviet scientists are making significant contributions to the field of space medicine and biology through their active manned space program, frequent biosatellites, and extensive ground-based research. It is important that U.S. space life scientists be familiar with the literature generated by the Soviet program. The purpose of this document is to provide an overview of the developments and direction of the USSR Space Life Sciences Program.

Information concerning the Soviet space program makes its way into U.S. information banks and publications via a number of routes. While many agencies survey the Soviet literature and produce helpful listings and translations, no agency reviews the full scope of Soviet life science literature pertinent to the space program, and no agency is specifically charged with the task of evaluating and integrating any of this information. This Quarterly Digest is designed to bridge that gap.

The information contained in this Digest is primarily obtained from the following sources:

- Abstracts in Soviet space biology and medicine provided by the Library of Congress, Science and Technology Division.
- *Aerospace Medicine and Biology*—A continuing bibliography (NASA SP-7011).
- *Scientific and Technical Aerospace Reports*—A bibliography produced by the Scientific and Technical Information Office, NASA.
- Foreign Broadcast Information Service, Volume III, Soviet Union—NTIS. Abbreviated FBIS.
- Daily Soviet News Abstracts Publication—Translated abstracts of news items from the Soviet press. Published by Foreign Technology Division, Battelle Columbus Laboratories. Abbreviated Daily SNAP.
- *Space Biology and Aerospace Medicine*—A complete translation of the Russian language monthly journal *Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina*, published in the U.S. by Joint Publications Research Service.
- *USSR Report, Biomedical and Behavioral Science*—Translated abstracts in biochemistry, radiobiology, aerospace biology, and medicine, from a variety of Russian language sources. Published in the U.S. by Joint Publications Research Service.
- *USSR Report, Space*—Translated abstracts of formal scientific reports and news items on the Soviet space program, from a variety of foreign language sources. Published in the U.S. by Joint Publications Research Service.
- *Aviation Week & Space Technology*—Weekly periodical published by McGraw-Hill, Inc. Abbreviated AW&ST.
- *Astronautics and Aeronautics*—Monthly periodical published by the American Institute of Aeronautics and Astronautics, Inc.
- *Aviation, Space and Environmental Medicine*—Monthly periodical published by the Aerospace Medical Association.
- *Spaceflight*—Monthly periodical published by the British Interplanetary Society.

The goal of this publication is to inform cognizant personnel of the NASA Life Sciences Division of important developments in the Soviet Space Life Sciences Program in a manner that eliminates the need for the arduous task of locating and reviewing the voluminous Soviet literature. Copies of literature cited in the Quarterly Digest may be obtained by contacting:

BioTechnology, Inc.  
ATTN: Soviet Digest  
3027 Rosemary Lane  
Falls Church, VA 22042

or

The Library of Congress  
Federal Research Division  
ATTN: Joseph Rowe  
Thomas Jefferson Bldg.  
ATTIC A  
Washington, D.C. 20540

## HIGHLIGHTS

### Launches and Recoveries

The following table presents an overview of recent Soviet launches and recoveries.

| Spacecraft       | Launch            | Crew                                   | Return            | Comments                                                                                                                                                                                        |
|------------------|-------------------|----------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cosmos 1187      | 12 June 1980      | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Gorizont         | 14 June 1980      | Unmanned                               |                   | Communications satellite                                                                                                                                                                        |
| Cosmos 1188      | 14 June 1980      | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Meteor           | 18 June 1980      | Unmanned                               |                   | Investigations of Earth natural resources                                                                                                                                                       |
| Molniya-1        | 21 June 1980      | Unmanned                               |                   | Communications satellite                                                                                                                                                                        |
| Cosmos 1189      | 26 June 1980      | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Progress 10      | 29 June 1980      | Unmanned                               | 19 July 1980      | Docked with Salyut 6 on 1 July 1980; delivered equipment, fuel, and food                                                                                                                        |
| Cosmos 1190      | 1 July 1980       | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1191      | 2 July 1980       | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1200      | 9 July 1980       | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1192-1199 | 9 July 1980       | Unmanned                               |                   | 8 satellites launched with one rocket carrier                                                                                                                                                   |
| Cosmos 1201      | 15 July 1980      | Unmanned                               |                   | Investigations of Earth natural resources                                                                                                                                                       |
| Ekra             | 15 July 1980      | Unmanned                               |                   | TV satellite                                                                                                                                                                                    |
| Molniya-3        | 19 July 1980      | Unmanned                               |                   | Communications satellite                                                                                                                                                                        |
| Soyuz 37         | 23 July 1980      | V. Borbatko<br>P. Tuan<br>(Vietnamese) |                   | Docked with Salyut 6 on 24 July 1980; crew returned to Earth in Soyuz 36 on 31 July 1980                                                                                                        |
| Cosmos 1202      | 24 July 1980      | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1202      | 25 July 1980      | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1203      | 31 July 1980      | Unmanned                               |                   | Film reconnaissance of Earth resources imagery; probably launched by an SS-9 booster as part of a plan to expand use of these vehicles as space launchers, as they are phased out of ICBM force |
| Cosmos 1204      | 31 July 1980      | Unmanned                               |                   | Minor military functions, such as assistance in radar calibration                                                                                                                               |
| Cosmos 1205      | 12 August 1980    | Unmanned                               |                   | Film reconnaissance (recoverable)                                                                                                                                                               |
| Cosmos 1206      | 15 August 1980    | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1207      | 22 August 1980    | Unmanned                               |                   | Investigations of Earth natural resources                                                                                                                                                       |
| Cosmos 1208      | 27 August 1980    | Unmanned                               |                   | Space research                                                                                                                                                                                  |
| Cosmos 1209      | 3 September 1980  | Unmanned                               |                   | Investigations of Earth natural resources                                                                                                                                                       |
| Meteor-2         | 9 September 1980  | Unmanned                               |                   | Meteorological satellite                                                                                                                                                                        |
| Soyuz 38         | 18 September 1980 | Y. Romanenko<br>A.T. Mendez<br>(Cuban) | 26 September 1980 | Docked with Salyut 6                                                                                                                                                                            |

## Mission News

- Leonid Popov and Valeriy Ryumin remain onboard Salyut 6; as of October 1 they will have broken the 175-day mission record set last year by Lyakhov and Ryumin. The two cosmonauts arrived at the space station on April 9, and have been actively engaged in experimentation throughout the 175-day period, particularly in the field of materials science. When the unmanned Progress 10 cargo spacecraft arrived on July 1, the cosmonauts received scientific equipment, food, and other supplies. In addition, the engines of Progress 10 were used to correct the station's trajectory. Just prior to the tanker's departure, Popov and Ryumin were asked for requests of cargo that future Progress missions should bring to the station. The men specifically requested a Polaroid camera, canned fish, tapes of Soviet popular music, a telescope with a zoom lens, sticky tape, and a 25 cm color television to watch the 1980 Olympics.
- On July 23, the Soviets launched Soyuz 37, which docked with the Salyut station the following day. The commander of the Soyuz mission was Colonel Victor Gorbatko, while Lieutenant Colonel Pham Tuan, a North Vietnamese fighter pilot, was the cosmonaut-researcher. Tuan suffered headache and loss of appetite during the first few days of the week-long visit to the station. Throughout the week, the entire crew of the station conducted a number of experiments dealing with Earth photography, lower body negative pressure, and materials processing. Gorbatko and Tuan were the third temporary crew to visit Ryumin and Popov at the space station; they returned to Earth July 31, in Soyuz 36, leaving the fresh Soyuz 37 at the space station.
- The fourth temporary crew was launched in Soyuz 38 on September 18, and docked with the station the following day. The commander of the mission was Yuri Romanenko, and the flight engineer was the 38-year-old Cuban, Arnaldo Tamayo Mendez, thus continuing the international experiment begun on earlier missions. Activities on the space station during the visit included several Cuban experiments in space processing (crystallization of sucrose in 0 G) and biomedical research (EEG recording, etc.)
- Experiments carried out aboard the station emphasize Earth resources photography, biomedical studies, and material science research. One group of studies involves the "Ispartitel" (evaporator). Coating materials such as gold, silver, and aluminum alloys containing silver and copper are vaporized in the apparatus by a powerful beam of electrons. The vapors are then condensed on metal, glass, and plastic plates for return to Earth. Other experimentation concerns determination of the effect of long-term space exposure on window glass, and optimal conditions for the growth of the algae fern Asola in 0 G. This Vietnamese fern reproduces rapidly, undergoing intensive nitrogen fixation, thus making it a promising candidate for use in ecological life support.
- The biomedical condition of the main crew of the station appears to be quite good. In early July, the director of the flight medical support group, A.D. Yegorov, commented on the ease with which Popov and Ryumin adapted to outer space. He pointed out that it is the first time cosmonauts in orbit have gained rather than lost weight; Ryumin gained 1 kg and Popov 2 kgs. The cosmonauts continue to exercise strenuously, logging on the

average 30-40,000 kg-m on the exercycle, and 4 to 5 kms on the running track daily. Additional biomedical data on the condition of the two cosmonauts were reported in the Soviet press on August 5. Popov's pulse rate averaged 72 beats/min and arterial pressure 130 to 60 mm; Ryumin exhibited a lower pulse rate of 60 beats/min and an arterial pressure of 120 to 60 mm. The doctors of the medical team noted that both cosmonauts retain high working capacity.

#### Personnel News

- **Viktor Gorbatko:** The pilot of Soyuz 37 was born in southern Russia in 1934. He served in the air force, and enrolled in a cosmonaut training program in 1960. Colonel Gorbatko participated in two previous spaceflights, Soyuz 7 (1969) and Soyuz 24 (1977).
- **Pham Tuan:** The cosmonaut-researcher of Soyuz 37 was born in North Vietnam in 1947. He served as a fighter pilot in the Vietnamese People's Army, and enrolled in the Soviet Air Force Academy in 1977. Lieutenant Colonel Tuan joined the cosmonaut training program in 1979.
- **Yuri Romanenko:** The pilot of Soyuz 38 was born in 1944, graduated from Chernigov Higher Military Aviation School for Pilots, and served as a flight instructor in the air force. Colonel Romanenko joined the Cosmonaut Corps in 1970. This is his second trip to the Salyut 6 orbital space station. He was the commander of Soyuz 26, and remained aboard the station for 96 days in 1977 and 1978.
- **Arnaldo Tamayo Mendez:** The cosmonaut-researcher of Soyuz 38 was born in Cuba in 1942, and attended aviation school after the close of the Cuban revolution. He entered cosmonaut training in the Soviet Union in 1978.
- **Boris Petrov:** The Chairman of the USSR Academy of Sciences "Interkosmos" Council died on August 23, at the age of 67, following a serious illness. Petrov's scientific contributions dealt primarily with automatic control technology.

#### Meetings

- The 5th All-Union Seminar on Modeling of the Ionosphere, sponsored by the USSR Academy of Sciences, was held in early July. Interest focused on the propagation of radio waves and spacecraft communications.

(Material in the "Highlights" is drawn from FBIS, July-September 1980; Daily SNAP, July-September 1980; and AW&ST, July-September 1980.)

## GROUND-BASED RESEARCH

### Space Medicine and Physiology

#### Hypokinesia

*Key words: physical conditioning, exercise, myasthenia gravis, musculoskeletal system*

Kapelovich (1979) discussed the use of physical conditioning regimes in the treatment of myasthenia gravis. The influence of exercise on myasthenic muscular degeneration, both before and after thymectomy, was studied in 200 patients; physical conditioning had a positive effect on muscular control in the majority of cases. He suggests that such conditioning regimes should play an integral role in the presurgical preparation and postsurgical management of patients with myasthenic disorders.

*Key words: Immobilization, sleep, paralysis, muscle degeneration, psychology, nervous system*

The effect of long-term hypokinesia on the structural organization of sleep was studied by Rotenberg et al. (1980). EKG, EEG, EMG, and electro-oculogram measures were utilized to characterize the sleep patterns of four individuals immobilized as a result of paralysis. A detailed discussion of the data obtained was presented. In general, a reduction in motor activity did not cause fundamental changes in sleep patterns.

*Key words: Soviet-American study, head-down tilt, antiorthostatic bedrest*

Gazenko and Grigor'yev (1980) discussed the joint Russian-American research program on the physiological effects of horizontal and antiorthostatic bedrest. The major goal of the program was to evaluate antiorthostatic bedrest as a model to simulate the spacecraft environment. In addition, an effort was made to standardize the physiological and biochemical techniques used in this type of experimentation. Results were reported in a volume edited by Gurovskiy (June 1980 digest).

*Key words: acceleration, artificial gravity, cardiovascular system, centrifuge, immersion*

The use of periodic acceleration in a small radius centrifuge as a countermeasure against the cardiovascular deconditioning associated with water immersion was examined by Vil'-Vil'iams and Shul'zhenko (1980). Subjects were exposed to accelerations of 0.8 to 1.6 G. Results indicated decreased cardiovascular deconditioning in the majority of cases.

*Key words: fluid-electrolyte metabolism, acceleration, renal function, immersion, kidney*

Shul'zhenko et al. (1980) investigated fluid-electrolyte metabolism during a 3-day water immersion study. Increased excretion of fluids and osmotically active substances was observed

(particularly on the first day) in 10 healthy men, 25 to 30 yrs of age. This increase in fluid-electrolyte excretion was attributed to a homeostatic mechanism designed to recover intravascular fluid. Several of the subjects were also exposed to low magnitude  $G_z$  acceleration during immersion. Exposure to acceleration mitigated the increase in excretion, and so normalized fluid-electrolyte metabolism.

**Key words:** *exercise, musculoskeletal system, antiorthostatic, bedrest, nervous system, LBNP, pharmacology, muscular degeneration*

Tishler et al. (1980) assessed the efficacy of exercise, both alone and in conjunction with other preventive measures, in moderating the muscular degeneration induced by 49 days of antiorthostatic (-4° head-down) bedrest. Twenty-four subjects were exposed to one of the following regimens: (1) periodic exercise on a "combination athletic exercising unit" (CAE); (2) periodic exercise on the CAE, lower body negative pressure (LBNP), and salt supplements; (3) periodic exercise on the CAE, LBNP, salt supplements, and 20 mg ephedrine plus 1 mg strychnine administered daily to the entire group from the 15th to the 25th day and to 3 of these subjects from the 39th to the 49th day; and (4) no preventive measures applied (control group). Neuromuscular function was compared in each of the groups via electrostimulation of the femoral muscles on the 5th, 19th, 33rd, and 47th days. The groups that engaged in periodic exercise demonstrated less muscular degeneration compared to the control group. The addition of other preventive measures to the exercise regimen, though, induced no further enhancement of neuromuscular activity.

**Key words:** *exercise, cardiovascular system, antiorthostatic bedrest, head-down tilt*

Katkovskiy and Buzulina (1980) studied the effect of exercise on the cardiovascular system during prolonged antiorthostatic hypokinesia. The 12 subjects were divided into 2 groups: 6 remained in -4° head-down tilt throughout the 45-study, and 6 combined exercise (twice daily) with antiorthostatic bedrest. Pulse rate was determined, both before and after the bedrest period, during loads of 100, 300, 600, and 800 kg-m/min. Less deterioration in cardiovascular response (lower pulse rate) was noted in the exercise group. In addition, the authors recommended the use of at least 800 kg-m/min for tests of cardiovascular function.

### **Exercise**

**Key words:** *physical conditioning, cardiovascular system, pulmonary system, respiration*

Vasil'yeva et al. (1979) developed an exercise program for improving the physical performance capacity of individuals engaged in sedentary occupations. The program utilized a bicycle ergometer and running track. Thirty healthy men, 25 to 35 yrs of age, participated in a 4-month test of this 84-exercise program. Performance capacity was measured before, during, and after the study. Results substantiated a general improvement in physical condition and aerobic potential. Specifically, a decrease in heart rate and arterial pressure and an increase in the vital capacity of the lungs were noted.

*Key words: physical conditioning, athletic training, cardiovascular system*

The "cardio-leader" device was tested in a variety of athletic training programs by Bondin (1979). This device emits a tone when the subject's heart rate is lower or higher than a pre-programmed range, thereby providing the player with feedback concerning physical exertion in different phases of the activity. Results indicated increased effectiveness of training programs that utilize cardio-leader monitoring.

### **Acceleration**

*Key words: performance, cardiovascular system, centrifuge, psychology*

Barer and colleagues (1980) conducted experiments designed to investigate the effects of prolonged +G<sub>z</sub> acceleration on human performance, focusing on psychomotor skills relevant to aviation. Thirteen men (aged 22 to 39) were tested in a flight simulator mounted in a centrifuge (8 m arm), using a task that involved tracking a moving marker light projected on a screen. Subjects were exposed to various acceleration levels for 40 sec, at angles of either 23 or 35° to the longitudinal axis of the human body. Results demonstrated that acceleration had a substantial effect on performance, as measured by relative tracking error and self-report measures of piloting capability. Increase in the angle of tilt of the seat appeared to provide improved circulation in the brain during acceleration exposure, and, consequently, improved performance on the tracking task and lowered the frequency and severity of associated visual disorders.

### **Vibration**

*Key words: auditory system, vestibular system, hearing loss*

Menyakin and Popovetskaya (1980) studied the effect of exposure to the high frequency acoustical and low frequency vibrational energies typical of oceangoing vessels on the auditory system. Clinical-audiological examination of 553 sailors and fishermen established hypoacusis of one degree or another in 43.7%. The extent of hearing loss was dependent on average age and length of service in the sea-based occupation. Changes in vestibular function were also found in 230 fishermen afflicted with cochlear neuritis via electronystagmographic, caloric, and rotation testing. A reduction in the duration of postrotational nystagmus was observed.

*Key words: sound, auditory system, stress, noise*

Karpova et al. (1979) examined the immediate organizational response to low frequency acoustical energy. Rats, rabbits, guinea pigs, and healthy male volunteers (19 to 29 years of age) were exposed to sound frequencies of 5 and 10 Hz and sound pressures of 100 and 135 decibels (15 min each). During the first few min of exposure, stress, unpleasant auditory sensations, and mild fatigue were noted. Over half of the human subjects complained of confusion and mild depression, while 20% developed headache and dizziness. Some felt vibration of internal organs.

Data obtained during exposure to low frequency oscillations via EEG, EKG, seismocardiograph, and audiometric analysis implicated infrasound as a causative factor in dysfunctions of cardio-pulmonary regulatory mechanisms.

## Radiation

*Key words: autoantibodies, hematology, book, radiation resistance, review*

Klemparskaya and Shal'nova (1977) published a book that reviewed both the Russian and foreign literature concerning radiation resistant antibodies (normal autoantibodies). The nature and physiological function of such autoantibodies, as well as their role in radiation resistance, the aging process, the immune response, and the phenomenon of organ sensitivity to the development of malignancy were examined in detail. Experimental data on the preparation of autoantibodies from animal and human blood for therapeutic applications were provided. The text of this book encompassed the following topics:

- Current data on the biological properties and role of radiation resistant antibodies of the peripheral blood system.
- Activators of normal autoantibodies.
- The significance of normal autoantibodies in the immune response in both non-irradiated and irradiated organisms.
- The function of normal autoantibodies as modifiers of long-term radiation effects.
- Normal autoantibodies and radiation resistance.
- The clinical application of normal autoantibodies as radiation resistant factors.

## Space Motion Sickness

*Key words: vestibular system, centrifuge, acceleration, nystagmus*

Sidel'nikov (1979) investigated a new method of estimating the condition of a pilot's vestibular organ, using centrifugation at different accelerations. Sixty subjects aged 20-40 were divided into two groups on the basis of their motion sickness susceptibility during a swing test. The nystagmus reactions of all subjects were tested using caloric stimulation under ordinary conditions and during exposure to acceleration on a centrifuge. Measurements of nystagmus differed in the subjects who were highly susceptible to motion sickness compared to those who were least susceptible.

*Key words: vestibular system, posture, equilibrium*

Mamasakhlisov (1979) investigated the human equilibrium preservation system during disturbances of the vertical posture caused by elevation of the supporting platform. Measurements included electromyograms and motion pictures. The study demonstrated that muscular responses to a disturbed vertical posture do not constitute a simple sequel to the extension reflex; the possible mechanisms are discussed with reference to a central program of equilibrium preservation.

*Key words: nystagmus, vestibular s, stem*

Poliakov et al. (1980) proposed a new procedure to measure individual susceptibility to provocative motion stimuli. The procedure involves the measurement of nystagmus response during specific rotary accelerations in a rotating chair. These researchers found that the intensity of nystagmus is higher for persons with low vestibular-autonomic stability than for persons with high stability. They also hypothesize that the dynamics of horizontal nystagmus disappearance can be used to detect persons with low and high vestibular-autonomic stability.

*Key words: vestibular system, nystagmus, central nervous system, traumatic brain disease*

Garshin and Volyanskiy (1980) discussed vestibular disturbances that accompany traumatic brain disease. Caloric stimulation and rotational testing were used to study vestibular function in 84 patients afflicted with this type of disorder. The majority reacted to stimulation of the vestibular apparatus with pronounced sensory and autonomic changes, such as vertigo and spontaneous nystagmus. Types of vestibular reactions found were dependent on the severity of the injury, duration of the post-traumatic period, and nature of the neurological symptoms observed. Threshold and suprathreshold tonal audiometry were applied to pinpoint the region of the vestibular apparatus affected. In general, function in both central and peripheral regions was disrupted. Therapeutic measures were presented that attempt to regulate vestibular function to minimize such disturbances in the residual phase of traumatic brain disease.

*Key words: vestibular system, ultrasound, Meniere's disease, otorhinolaryngology, book*

Soldatov (1979) published a text that analyzed the results of clinical and experimental studies involving the use of ultrasound in otorhinolaryngological (ORL) diseases, covering both the biophysical properties and therapeutic effects of ultrasound. Much experimental substantiation for the use of ultrasonic therapy in certain diseases of ORL organs was provided. The author states that a focused ultrasonic beam produces destruction of neurosensory and secretory epithelia in the peripheral region of the vestibular apparatus without having a significant influence on the functions of the cochlear receptors. He suggests that ultrasound may be used in the treatment of such ORL disorders as chronic tonsilitis, vasomotor rhinitis, chronic maxillary sinusitis, and Meniere's disease.

*Key words: exercise, seasickness, vestibular system*

Salanin (1979) investigated the effectiveness of physical conditioning in increasing resistance to motion sickness (seasickness). An exercise program designed for naval personnel was tested in three experimental trials. Results supported the usefulness of physical conditioning of almost any type in reducing vestibular disturbance and, thus, increasing performance capacity.

*Key words: vestibular system, nystagmus, Meniere's disease, book*

Blagoveshchenskaya (1980) reviewed a book entitled *Vestibular Crises* by I. Ivanov, which was published in 1977. The book discusses the etiology, pathogenesis, and treatment of a variety of vestibular dysfunctions, including Meniere's disease, kinetoses, neuroses, vascular cerebral disorders, cervical spondylosis, and traumatic brain injury. The author surveyed thousands of clinical patients with vestibular symptoms, and described modern methods of diagnosis and measurement, such as electronystagmography, measurement of vestibulo-autonomic reactions, audiometry, and cupulometry. The reviewer states that despite some small shortcomings, the text is a good manual for otorhinolaryngologists, otoneurologists, and neuropathologists.

*Key words: vestibular system, nystagmus, chorioependymitis*

Ladyzhenskaya and Arifdzhanyan (1979) present clinical observations supporting the potential usefulness of vestibular function determinations in the diagnosis of the occlusion form of chorioependymitis. Chorioependymitis is an inflammation of the choroid plexi and walls of the cerebral ventricles. Intensive production of fluid in the first phase of this disease causes an increase in intracranial pressure. In the second phase, a decrease in fluid secretion and so intracranial pressure (below normal levels) is due to progressive sclerosis in the choroid villi and ependyma. A constriction in the foramina of Magendie and Monro, occlusion-hydrocephalic syndrome, results in a limited number of cases. Diagnosis is particularly difficult in this occlusion form because of a lack of correlation in clinical and paraclinical data. Vestibular disorders, particularly changes in tonicity of nystagmus, have been found, though, in nearly all patients with the occlusion form of chorioependymitis. Therefore, it is likely that the true state of intracranial fluid dynamics is reflected by a dysfunction of the vestibular apparatus. The use of otoneurological methods that measure vestibular reactions may facilitate diagnosis in cases where methods such as spinal tap and craniogram prove to be ambiguous.

*Key words: electrostimulation, vestibular system, nystagmus*

Khechinashvili et al. (1978) developed a technique for applying electrical stimulation to the vestibular apparatus in humans, in order to obtain related measurements of nystagmus without causing excessive pain. The technique involves bipolar direct current stimulation applied to the left and right ear, using a trapezoidal shaped electric pulse. The researchers indicated that bipolar applications rather than monopolar, and gradual rather than abrupt changes in current strength, tended to produce optimal nystagmus at amperages well within human tolerance limits (approximately 3.5 mA). They further suggested the application of a local anesthetic to allow the use of higher currents.

*Key words: vestibular system, seasickness, countermeasures, nutrition, exercise*

Yefremenko (1979) reviewed methods for the prevention and treatment of seasickness. Various prophylactic measures suggested included physical training, maintenance of an environment conducive to physical and psychological well-being, and, as a last resort, the administration of one of a number of preventive drugs. Forms of treatment are dependent upon the clinical form of illness present. Seasickness may be latent, manifesting only a general bodily discomfort; or overt, showing either nervous, gastrointestinal, cardiovascular, or mixed symptoms. Therapeutic measures should be aimed at the affected part of the body, as well as a stabilization of the metabolic, electrolytic, and acid-base condition of the organism. Medications appropriate to symptom type include:

| <u>Clinical Form</u> | <u>Medication</u>                                                                                         |
|----------------------|-----------------------------------------------------------------------------------------------------------|
| 1. Gastrointestinal  | Anesthesin, Novocain                                                                                      |
| 2. Cardiovascular    | Validol, Corvalol, Valocordine, Cardiamine, Zelenin Drops                                                 |
| 3. Nervous           | Medinal, Mixtures of Syabro and Okunev, Suprastine, Dramamine, Pipolphene, Diprazine, Dedalone, Aminazine |
| 4. General           | Scopolamine (sedative).                                                                                   |

The value of a diet rich in vegetable purees and lean meat, which aids in counteracting inhibited peptic secretory function, was also discussed. In addition, Yefremenko suggested the administration of substances that enhance the non-specific resistance of the organism, such as vitamins, dibasol, ginseng, and schizandra; these substances may help to achieve the overall goal of optimizing the work capacity of sea-based personnel.

*Key words: orientation, vestibular system, psychology*

The effect of angular orientation on the identification of two-dimensional random shapes was examined by Bozhkov et al. (1979). Subjects were presented with 9 figures in 16 angular positions (0-360°) for a period of 5 sec each. Each subject was then asked to verbally describe the figure, by stating whether the figure reminded him or her of anything. In general, the descriptions of the figures did not depend on angular orientation but did depend on the figure's shape, regardless of orientation.

*Key words: stress, naval, nervous system, human factors*

The increased complexity of modern naval equipment is thought to strain central nervous system capacities and generally result in intensified nervous tension and stress reactions. Solodkov and Lobzin (1980) discussed methods to minimize such stress in naval personnel. The syndrome is thought to fall into one of 3 categories: emotional stress, hyperstimulation of higher nervous activity, or physiological stress resulting from the hypokinesia, partial sensory isolation, and perceptual deprivation associated with prolonged shipboard cruises. Resistance to symptoms may be increased by exposure to comprehensive naval training programs. Careful selection of psychologically and socially compatible crewmembers who are capable of functioning well as a unit may mitigate reactions. These stress responses may sometimes be accompanied by various vegetative disorders, and the author pointed out that it is important to distinguish between such neurotic reactions and physiological changes due to unfavorable environmental conditions in order to effect proper treatment and preventive measures.

*Key words: hypothalamus, hippocampus, electrostimulation, rabbit*

Boravova (1979) investigated the functional relationship between the posterior hypothalamus and the dorsal hippocampus in rabbits. Electrical stimulation of posterior hypothalamic sites (supramammillary and mammillary bodies) produced orienting behavior in preliminary tests. The same kind of electrical stimulation produced alterations in neuronal activity in the dorsal hippocampus. The dominant response of hippocampal neurons was tonic activation or inhibition with lengthy aftereffects. Increased frequency of stimulating currents produces an increase in the number of hippocampal units responding and in the reactivity of neurons. Boravova concluded that the orienting behavior is partly the result of nonspecific activation of the dorsal hippocampal cells by neurons in the posterior hypothalamus.

*Key words: neurophysiology, central nervous system, sensory deprivation, book*

Vasilevskii (1977) published a book entitled, *Ecological Physiology of the Brain*. The book examines neural physiological adaptive mechanisms and emphasizes a number of issues:

1. adaptive self-regulation and the "plasticity" of neural processes;
2. the effects of extreme conditions (including sensory deprivation) on the adaptive plasticity of the brain;
3. operant controlled neural activity;
4. elementary selective response systems; and
5. mechanisms of reflexes as forms of selective response.

*Key words: altitude decompression, EEG, central nervous system*

Goroian and Zakharova (1980) investigated the effects of altitude decompression on a number of measures of nervous system function. Subjects under decompression were tested for spontaneous EEG, latent visual-motor response, stability of attention, and thresholds of tactile and pain sensitivity. A period of subjective well-being before the actual decompression disorder was identified, which was characterized by a lessening of attention and a lowering of thresholds of tactile pain sensitivity. A definite correlation was found between the resistance of individual subjects to altitude decompression and spontaneous EEG patterns.

*Key words: stress, pilot, carbohydrate metabolism, glycogen, neutrophils, endocrinology*

The stress reactions of aircraft pilots were examined by Pashchenko et al. (1980). Stress tends to activate the adenohypophyseal system, thus stimulating carbohydrate metabolism. The authors chose to indirectly study adenohypophyseal function by monitoring two parameters of carbohydrate metabolism, intracellular glycogen concentration and phosphorylase activity, to avoid the difficulties associated with direct quantitative analysis of adenohypophyseal hormones. Samples of peripheral neutrophils were obtained from 18 pilots and analyzed for glycogen and phosphorylase concentration 2 hrs before and 15 mins after aircraft flight. Ten of the subjects were student pilots who should exhibit comparatively less stress reaction than the 8 experienced pilots. No significant increase in glycogen or phosphorylase levels were found postflight in student pilots. Experienced pilots, on the other hand, did exhibit significant increases in both of these parameters. Therefore, these researchers concluded that variations in the phosphorylase and glycogen concentration of peripheral neutrophils may be used as a valid indicator of the extent of the stress reaction to flight conditions.

*Key words: brain injury, automated systems, computer, diagnosis*

Moiseyeva et al. (1979) reported on an automated system for diagnosing craniocerebral injury that has been operating in Leningrad since 1973. The advantages and details of the system are reviewed, and the author cites data that indicate computer diagnosis of specific craniocerebral injuries has been more accurate than medical diagnosis.

### **Simulation Studies**

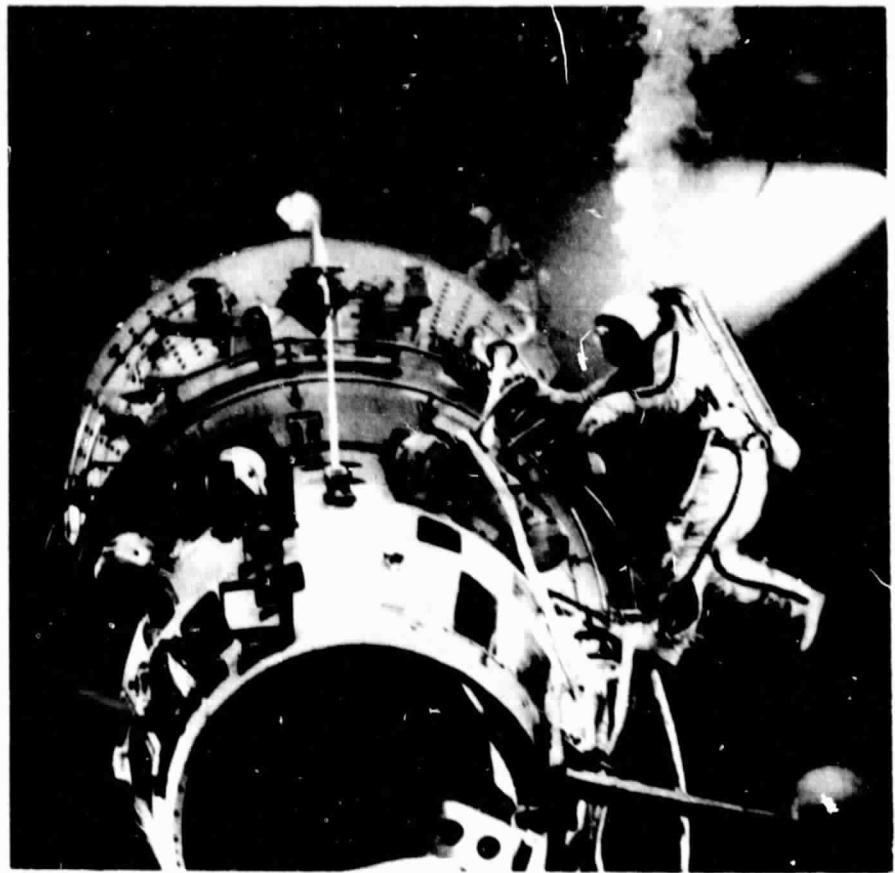
*Key words: hydrolaboratory, cosmonaut training, Salyut, Soyuz*

Reproduced below are TASS (1980) photographs of the "hydrolaboratory" in the Cosmonaut Training Center at Zvezdnyy Gorodok. This installation includes submerged life-size and fully equipped Salyut and Soyuz models. During training cosmonauts wear pressure suits with life support backpacks, as shown.



General G. Beregovoy (Director of Yuriy Gagarin Center),  
and General H. Kamanin, inspecting the installation.

ORIGINAL PAGE IS  
OF POOR QUALITY



*The submerged Salyut simulator.*

*Key words: motor system, mathematical model, musculoskeletal system, posture*

Penev and Tairov (1979) theorized on possible mechanisms of adaptive control over human and animal motor systems using a number of mathematical models. Equations are described for cases in which the motor system uses information about the position or movement acceleration of its parts. The model proposes that the control system may function in two operational modes. An important feature of the first mode is the execution of measured control leaps that identify the condition of the system and provide for more precise correction of ongoing movement. The second mode is characterized by the estimation of movement direction only. This highly mathematical article may be of interest to researchers involved in bioengineering.

*Key words: cardiovascular system, mathematical model, computer simulation, orthostatic, clinostatic*

A mathematical model to simulate conditions in the human cardiovascular system during clino- and orthostasis was proposed by Palets and Grigoryan (1980). The model, based on an ALGOL program for a BEhSM-6 high-speed computer, takes into account the self-regulatory nature of the heart and the resistance-capacitance properties of the blood vessels. Both the sensitivity of minute blood volume ( $Q$ ) and mean arterial pressure ( $P_A$ ) to changes in heart rate ( $F$ ), inotropic state of the heart ( $k$ ), total peripheral resistance and relaxed volume ( $U$ ), and the inflexibility of the venous pool ( $D$ ) during clino- and orthostasis may be determined by this computer system. During clino- and orthostasis,  $Q$  and  $P_A$  are found to be most sensitive to changes in  $U$ . With a shift to the vertical, however, the sensitivity of  $Q$  and  $P_A$  to  $k$  and  $F$  decreases, while their sensitivity to changes in  $D$  increases markedly. During orthostasis, blood volume and pressure in the central regions of the cardiovascular system are decreased and blood flow is reduced. Neural circulation is also found to be reduced, and total peripheral resistance increased following 3 sec of orthostasis. Such changes may be attributed to a pronounced drainage of blood from upper to lower regions of the vascular system. Regulation of circulatory function may be attributed to a variable control structure that modifies the system by varying numerous cardiac and vascular parameters.

*Key words: antiorthostatic bedrest, cardiovascular system, head-down tilt*

Geykhman and Mogendovich (1980) investigated several physiological parameters in humans in response to antiorthostatic positions ranging from  $-4^\circ$  to completely reversed vertical. The complete antiorthostatic position was associated with markedly reduced heart rate and other drastic cardiovascular adjustments. These scientists suggest that a special antiorthostatic position, which involves elevating the legs and bending them at the knees, simulates the effects of weightlessness more closely when it is used in conjunction with prolonged hypokinesia.

*Key words: antiorthostatic bedrest, hypokinesia, cardiovascular system, nervous system, rheoencephalogram*

Yarullin et al. (1980) investigated individual differences in the response of the cerebral circulation to the antiorthostatic position. Cerebral circulatory function was characterized in 40 healthy male subjects, 22 to 39 yrs of age, following 2 successive head-down tilts of -15 and -30° (6 min each). Rheogram, rheoencephalogram, and EKG analysis were utilized to divide the subjects into 2 groups (good and satisfactory) based on tolerance to head-down tilt. Subjects who displayed good tolerance to the antiorthostatic position exhibited an increase in the tone of arteries and arterioles of the brain, and increased cerebral blood filling (particularly at -30°). In those who displayed only satisfactory tolerance, a slight increase in the tone of the arteries; a decrease in the tone of arterioles, veins, and venules; and a significant increase in cerebral blood filling were noted.

*Key words. symposium, computer simulation, neurophysiology, cardiovascular system, respiratory system*

Lange (1980) reviewed the major trends in modern physiology discussed at the 13th Congress of the I.P. Pavlov All-Union Physiological Society held at Alma-Alta from September 24-28, 1979. Major interest was focused once again on neurophysiology and higher nervous activity. Symposia on the physiology of sense organs and visceral systems, evolutionary and ecological physiology, and the use of computers in physiological research were conducted. Mechanisms of vestibular function were elucidated in reports concerning the hypothalamic regulation of vestibular activity, synaptic mechanisms that control the activation of the red nucleus, and the role of the vestibular nucleus in the formation of neurohumoral reactions to labyrinth and extralabyrinth stimulation. In the area of cardiovascular and respiratory physiology, presentations were made on the contractile function of cardiac muscle during long-term adaptation and readaptation, the analysis of respiratory regulatory mechanisms under varying environmental conditions, the adaptation of equilibrium systems to hypoxic conditions, and the cellular mechanisms of adaptation to hypobaric hypoxia. In addition, discussions on the problems that arise when using computers for processing physiological data and in automated physiological research methods may be of interest to the aerospace biologist.

*Key words: Bulgaria, cardiovascular system, hypoxia, psychology, radiation*

Serafimov (1979) discussed highlights of the Bulgarian space research program in biology and medicine. Experimental methods and results in each of 3 areas were summarized. The first area concerns the effect of spaceflight factors on the physiological state of the organism, particularly circulatory and respiratory changes induced by exposure to a hypoxic environment; cardiovascular adaptations to positive radial acceleration; and methods for decreasing vestibular sensitivity. A second phase of the program involves radiobiology and radioprotective measures. Studies attempt to evaluate the genetic risk of irradiation by galactic space radiation and to determine the effect of nonradiation factors, such as permanent magnetic fields and biogenic stimulation on radiation injury. In addition, much emphasis is placed on the development of pharmacochemical protective measures. The final area of interest concerns the formulation of psychological selection criteria to insure emotional stability and operator reliability in future cosmonauts.

### Hypokinesia

*Key words: metabolism, biochemistry, immobilization, stress, epinephrine, glycolysis*

Fedorov (1980) discussed the effect of hypokinesia on protein, carbohydrate, and lipid metabolism. An analysis of the pathogenic mechanisms controlling changes in metabolic pathways was presented. During immobilization the organism must adapt both to psychological stress and to loss of the regulatory influence of motor activity. Stress acts to increase epinephrine levels, which in turn activates lipases in fatty tissue and stimulates nonesterified fatty acid production. Loss of the regulation induced by motor activity results in increased breakdown of tissue proteins and decreased ADP formation. Interference with the tricarboxylic acid (TCA) cycle occurs when the excess ammonia formed during proteolysis binds to oxaloacetic and  $\alpha$ -ketoglutaric acid. Thus, during hypokinesia oxidative phosphorylation is impaired by the increased nonesterified fatty acid levels, decreased ADP levels, and interference with the TCA cycle; and a shift to glycolytic respiration occurs.

*Key words: exercise, cardiovascular system, musculoskeletal system*

Potapov (1980) studied the efficacy of exercise in preventing the cardiac and skeletal muscle degeneration caused by hypokinesia. Rats were placed in one of four groups in this 90-day study: (1) hypokinesia (by confinement in a small cage) without exercise, (2) hypokinesia with exercise (40-min swim every 3rd day), (3) vivarium control without exercise, and (4) vivarium control with exercise (same regimen). Animals were sacrificed on the 15th, 30th, 60th, and 90th days. The content of collagen, aminopolysaccharides, and glucosaminoglycans in both the ventricular myocardium and femoral musculature was determined on analysis of the dry tissue powder. The results demonstrated no relationship between exercise and alterations in cardiac and skeletal muscle tissue. Thus, this exercise regimen was not an effective countermeasure against the muscular atrophy associated with hypokinesia.

*Key words: body fluid redistribution, cardiovascular system, stress, liver, rat*

Kovalev et al. (1980) studied the regional distribution of blood in rats exposed to hypokinesia. Rats were confined in hypokinetic cages for 7 and 30 days, then sacrificed. Regional blood volume was determined by use of  $^{51}\text{Cr}$ -labeled donor rat erythrocytes and  $^{131}\text{I}$ -labeled human serum albumins injected 10 min prior to death. Results indicated a slight increase in the total circulating blood volume, with the greatest local increase in the liver. The authors conclude that such an increase in blood volume is a reaction to the stressful, hypokinetic conditions.

*Key words: pancreas, lipid metabolism, rat, immobilization, lipase, enzyme*

Medkova et al. (1980) studied the changes in distribution of pancreatic lipase during prolonged restriction of motor activity. Rats were confined in hypokinetic cages for 20, 60, 90, and 120 days. Measures of the enzyme were then obtained for blood, pancreas, stomach, salivary gland tissue, and bile. Twenty days of hypokinesia had virtually no effect on enzyme distribution. Decreased activity of pancreatic lipase in the pancreas and increased activity in the blood serum, salivary glands, gastric mucosa, and bile were noted after 60, 90, and 120 days of restricted motor activity. The authors attributed the high levels of pancreatic lipase found in the digestive glands to an adaptive process designed to stabilize hydrolase levels in the peripheral blood serum and to create optimal conditions for the hydrolysis of lipids during hypokinesia.

*Key words: stress, adaptation, rat, immobilization*

Chernov (1980) examined the resistance of the organism to hypokinetic stress. Two hundred and fifty male rats were confined in hypokinetic cages for varying periods of time ranging from 3 hrs to 90 days, and the severity of the stress reaction was determined based on general body condition, state of the hypothalamohypophyseal system, and sensitivity to ionizing radiation. A three-phase stress reaction developed in response to immobilization. Periods of increased motor activity (10 days), adaptation (20-30 days), and loss of adaptive potential (>2 months) were observed. Hypokinetic stress tended to decrease both general bodily resistance and sensitivity to ionizing radiation.

*Key words: cold stress, immobilization, adrenaline, adrenal gland, catecholamines, extreme temperature*

Matlina et al. (1974) examined the effects of two consecutive stressors (cooling and immobilization) on catecholamine metabolism in the rat. Experimental animals were cooled for 8 hrs at 7°C on the first day and immobilized for 6 hrs on the next day. Histochemical tests led to a number of conclusions: (1) the successive action of cooling and immobilization results in a stronger decrease in the adrenaline and noradrenaline content in the adrenal gland than that which could be due to a simple summation of the effects of cooling and immobilization; (2) successive cooling and immobilization are followed by activation of catecholamine synthesis in the adrenal gland; and (3) L-DOPA administration activated catecholamine synthesis in the adrenal glands of both the control and experimental animals.

*Key words: fowl, protein metabolism, muscle tissue, musculoskeletal system*

Nvota et al. (1977) investigated the effects of hypokinesia on physiological functions in fowl. Changes in endocrine functions, metabolic reaction, body weight, growth, and proteosynthesis in muscle tissue were examined after 35 days of confinement in small cages. Although the hypokinesia speeded up the process of protein metabolism in the muscle, other physiological functions were not affected. These findings in birds are considerably different from those obtained in laboratory mammals exposed to hypokinesia. The researchers attribute this difference to phylogenetic remoteness of the two species and to domestication.

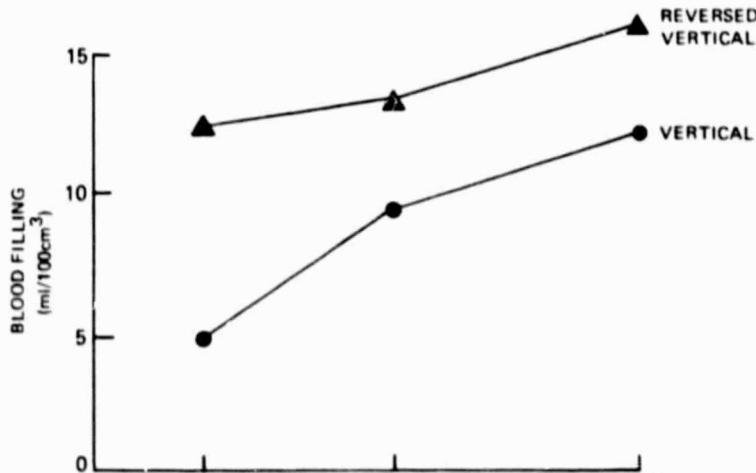
*Key words: weightlessness, simulation, body fluid redistribution, rat*

Il'in and Novikov (1980) present a brief description of a harness designed to simulate weightlessness in rats while still allowing the animal to retain freedom of mobility about a vivarium. The rat is supported by a harness attached to a movable platform above the vivarium. The harness is adjusted to remove weight load partially from the forelegs and fully from the hindlegs, resulting in an increased supply of blood to the upper end of the trunk and head. An advantage of this method is the elimination of restlessness and aggressiveness inherent to the first few days of other more conventional methods for simulating weightlessness. Similar changes in bone structure and body weight were noted in rats having spent identical periods of time aboard biosatellites as in the harness.

#### **Lower Body Negative Pressure**

*Key words: respiration, body position, antiorthostatic, cat*

Pogodin and Mazhbich (1980) studied the shifts in pulmonary hemodynamics caused by changes in body position in anesthetized cats. Regional electroplethysmography was used to quantitatively evaluate blood volume and blood flow in individual pulmonary sections (apical, medial, and basal). In the horizontal position (lying on back), dorsal pulmonary sections showed the highest blood filling ( $14.1 \text{ ml}/100 \text{ cm}^3$ ) and minute volume of blood flow ( $355 \text{ ml}/100 \text{ cm}^3$ ); the ventral section showed the least blood filling ( $11 \text{ ml}/100 \text{ cm}^3$ ) and minute volume of blood flow ( $258 \text{ ml}/100 \text{ cm}^3$ ). The figure below shows the results of the blood filling measure in the vertical (head upwards) and reversed vertical positions for apical, medial, and basal pulmonary sections. The volume measurements showed similar trends. The authors conclude that the gradient of blood flow in the lungs is determined primarily by gravity and exists in all body positions; however, the apical regions of the lungs have lower blood filling than the basal regions, regardless of body position.



(From Pogodin & Mazhbich, 1980)

## Radiation

*Key words: renal, kidney, chromosomal aberrations, gamma radiation*

Machavariani (1979) studied the effects of in vivo and in vitro radiation exposure, using tetraploidy formation in monkey epithelial kidney cells as a measure. Cell cultures were gamma irradiated at varying doses (25-200 R) for the in vitro experiments; for the in vivo experiments, cell samples were obtained from monkeys irradiated at 620-660 R, 2 wks, 2 months, and 10 months after radiation exposure. The cells irradiated in vitro showed an increase in the number of tetraploid cells dependent upon the dose of radiation and the age of the culture. In vivo radiation also produced significant increases in the number of tetraploid cells. The number of simple tetraploid cells increased from 2 wks to 10 months after in vivo exposure, but the number of complex tetraploids decreased with time, demonstrating the elimination of the most damaged cells. He suggests that the data on radiation damage in monkey renal epithelial cells can be used to supplement biological dosimetry data based on lymphocyte tetraploidy, since the radiosensitivity of the monkey kidney cells and peripheral blood lymphocytes is similar.

*Key words: book, gamma radiation, hematology, immunology*

In a book by Belousova et al. (1979) new information is reviewed concerning the effects of radiation on the blood system. The book describes studies performed under conditions of acute (100-900 rads) and chronic (150-9000 rads daily) external radiation in several species, including rats, guinea pigs, rabbits, mice, and dogs. The dynamics of radiation-induced hemopoietic changes are elucidated based on a quantitative evaluation of measured hematological indices of both peripheral blood and lymphoid organ cell types. This approach permits a comparison of the varying radiosensitivities and regenerative potentials of cellular elements in the hemopoietic system of different species of animals. The book also examines the relationship between dose and time parameters to interphasic maximal cell destruction and recovery following acute radiation exposure in different species. Other topics include the role of lymphoid tissue in the post-radiation recovery process, and the changes manifested in hemopoietic tissue following chronic gamma-irradiation.

*Key words: UV radiation, symposium, photoradiation, photobiology*

Troshin et al. (1979) published a collection of articles concerning the cellular and molecular mechanisms underlying the effects of solar (UV and visible) and laser radiation on oil-synthesizing organisms. Material in the book was drawn exclusively from reports presented at the First All-Union Symposium on "The Pathobiology of the Living Cell," held in Leningrad in November 1977. Current trends in animal photobiology appear to fall into three major categories. The effects of UV and visible radiation on proteins and cell membrane components, particularly as related to mechanisms of protein and membrane lipid photooxidation and of enzyme photoinactivation, is one such category. Also of interest are the biological effects of photoradiation on DNA and nucleic acid, and of subsequent DNA reparative processes, as well as the direct cytoplasmic mutagenic action of UV light during embryogenesis. Finally, the morphological, cytogenetic, physiological, and biochemical aspects of cellular photoinjury, including effects on DNA and RNA synthesis, mitotic activity, muscle and nerve function, vegetative function, enzyme systems, and immunocompetent cells are discussed by many of the leading Soviet authorities in this field.

*Key words: musculoskeletal, X-rays, transplant*

Il'yasova and Popova (1980) are investigating the use of helium-neon laser beams to facilitate the recovery of X-irradiated muscle tissue. In the first series of experiments, the entire gastrocnemius muscle of the rat was autografted; in the second, autografting of the muscle was preceded by irradiation of both hind limbs with a dose of 1000 R; in the third series, X-irradiation with the same dose was followed by a 10-day treatment with helium-neon laser, followed by autografting of the muscle. Transplantation regeneration was analyzed histologically after 2 wks, 1 month, and 2 months. The laser therapy produced the best results when it was applied before rather than after autografting the muscle, suggesting that the beneficial effect of the laser on postradiation recovery was due to its effects on the whole muscle, rather than solely to the elimination of the muscle elements that were most damaged by X-rays. These scientists hypothesize that the laser intensifies energy processes in the cells, contributing to the formation of ATP that directly participates in the postradiation reparation of membranes, chromosomes, and other organelles.

*Key words: chromosomal aberration, gamma radiation, monkey, lymphocytes*

Dzhemilev (1979) assessed the effects of in vitro and in vivo radiation effects in somatic cells of monkeys, in order to determine the usefulness of cytogenetic studies on monkeys as a model for human radiation exposure. In the in vivo tests, the animals were subjected to 100 R gamma radiation, and lymphocytes and renal epithelial cells were examined for chromosomal aberrations. Lymphocytes and renal epithelial cells from non-irradiated monkeys were exposed to the same dose of radiation in vitro for comparison. Analysis of chromosomal aberrations from the in vivo and in vitro radiation exposures revealed no differences, suggesting that cytogenetic studies of in vitro radiation exposure is a useful model.

#### **Space Motion Sickness**

*Key words: vestibular system, Deiter's nucleus, antiorthostatic, cat, central nervous system*

Panchin (1979) investigated single unit activity of vestibulo-spinal neurons in the Deiter's nucleus of decerebrate cats in response to tilting in the frontal plane. Vestibulo-spinal neurons were identified by means of antidromic responses to electrical stimulation of the ventral portion of the spinal cord. Thirty-nine of the 51 neurons examined demonstrated pronounced alterations in spiking activity in response to the vestibular stimulation provided by tilting. The activity of the neurons tended to increase with a tilt toward one side, and decrease with tilting towards the other side. The majority of these neurons (28 of 39) showed maximum activity following ipsilateral tilting. This researcher also categorized the vestibulo-spinal neurons into "fast" and "slow" by the duration of the latency response after antidromic stimulation. The "fast" cells were mainly stimulated by tilt towards the ipsilateral side, and the "slow" neurons were mainly stimulated by tilt towards the contralateral side. It was concluded that "fast" and "slow" vestibulo-spinal neurons respond differently to stimulation of vestibular receptors.

**Key words:** *vestibular system, electrostimulation, central nervous system*

Gayday (1979) studied the mode of activation of motor neurons in the cervical spinal cord by electrical stimulation of the medial longitudinal fasciculus (MLF), Deiter's vestibular nucleus (VN), and the red nucleus (RN). Analysis of the spatial distribution of electrical fields that emerged in the spinal cord during stimulation of the 3 nerve centers verified the fact that interaction of stimuli occurs prior to activation of the motor neurons. Techniques for stimulating the MLF, VN, and RN, and for recording focal potentials were standard. Only neurons of the central section of the VIII and adjacent sections of the VI lamina were activated by stimulation of the MLF, VN, and RN. The existence of an interneuronal apparatus activated by stimuli from the 3 nerve centers is indicated by the overlapping foci of activity.

### **Life Sciences Technology**

#### **Bioinstrumentation**

**Key words:** *ultrasound, hypoxia, hyperbaric, gas bubbles*

The use of ultrasound to detect gas bubbles in the venous blood of animals exposed to hypoxic conditions was described by Kazakova (1980). The system utilized an ultrasonic instrument, a sensor composed of 2 barium titanate crystals enclosed in plexiglas parallel to one another, and the recorder portion of an electroencephalograph. As a demonstration, the author monitored gas bubble formation in the circulatory systems of rabbits and cats exposed to hyperbaric environments. Data exhibited the typical species-specific dynamics of gas bubble formation.

**Key words:** *gas chromatography, rat, chemical analysis*

Sopikov and Gorshunova (1980) described a new method for isolating volatile organic compounds from biological tissues and fluids for gas chromatographic analysis. The method involves direct thermal evaporation of thin sections of the organic material (120°), allowing attachment of volatile compounds to conventional chromatographic columns. Tissues and blood samples from rats injected with 1,4-dioxane were analyzed by this method. Results indicated a 95-98% accuracy level. Advantages over conventional tissue homogenation methods include the ability to determine the distribution of substances within small organs and relatively fast preparation time.

#### **Toxicology**

**Key words:** *hyperbaric hyperoxia, respiratory system, decompression*

Gulyar (1980) investigated the interrelations of basic respiratory and hemodynamic parameters that determine rate of oxygen transport during hyperbaric hyperoxia. Thirty-two divers, 22 to 33 yrs of age, were subjected to 4 different helium-oxygen regimes, 20.9 and 13.3% O<sub>2</sub> at 2.5 and 4 kgf/cm<sup>2</sup> (P<sub>O<sub>2</sub></sub> = 384, 204, 618, and 393 mm Hg, respectively). Composition of the gas mixture

and respiratory and circulatory parameters were monitored directly by an experimental control system called "Barograf." When at rest, hyperbaric hyperoxia did not cause significant changes in body oxygen demand, minute volume, or respiratory frequency. Respiratory volume and dead space, however, did increase. The partial  $\text{CO}_2$  pressure of the alveoli remained unaffected by a pressure of 2.5 kgf/cm<sup>2</sup>, but increased by 75% at a  $\text{PO}_2$  of 618 mm Hg. During more strenuous exertion, a reduction in the minute blood volume by 14.9-19.2% appeared to be due to increased total peripheral resistance. Bradycardia and reduction in systolic volume played a less important role. The ventilation/perfusion ratio was found to be highest at 4 kgf/cm<sup>2</sup>, exceeding base values by 40.5-42.1%. The respiratory and hemodynamic shifts during hyperbaric hyperoxia are thought to be caused by an increase in arterial blood oxygen tension resulting from the increased plasma diffusion rate and more complete saturation of hemoglobin. The rate of oxygen entry into the respiratory tract was found to increase by 164.7-361.1% and 170.8-371.3% at 2.5 and 4 kgf/cm<sup>2</sup>, respectively, while the rate of oxygen transport in arterial and mixed venous blood decreased. In general, oxygen transport rates showed a decrease at the stage of oxygen entry into the lungs and an increase at the stage of incorporation into the blood system. Therefore, a reduction of oxygen content in inspired air promotes normalization of the body oxygen regime; however, normal oxygen mixtures may be physiologically optimal for the pressure range studied.

*Key words:* *gas chromatography, hyperbaric hyperoxia, respiratory system, decompression*

Gulyar (1980) also utilized the techniques of gas chromatography to investigate blood respiratory function in humans exposed to hyperbaric conditions. Gases were isolated from the blood in an extraction chamber and components separated via a two-column system, consisting of a silica gel column (nitrogen-oxygen +  $\text{CO}_2$ ) and a column with SA molecular sieves (nitrogen + oxygen). Quantitation based on peak heights allowed a determination of the relative amounts of gaseous constituents. An increase in the pressure of respiratory oxygen was observed to be accompanied by an increase in  $\text{PO}_2$  and  $\text{CaO}_2$ , with  $\text{CaO}_2$  exceeding base levels by 17.8% at 4 kgf/cm<sup>2</sup>. The addition of nitrogen to the respiratory mixture tended to limit the  $\text{CaO}_2$  to a 7.5% increase at 6.5 kgf/cm<sup>2</sup>. Of particular interest is the fact that decompression did not cause immediate return to normal of elevated  $\text{CaO}_2$  levels. Gulyar postulates that increased  $\text{CaO}_2$  under hyperbaric conditions is due to the more complete oxygenation of hemoglobin, as well as to the increased plasma diffusion rate. Ratios of blood buffer system parameters were largely unaffected by the hyperbaric conditions, even though a shift to more acid pH and an increase in  $\text{CaCO}_2$  and  $\text{PaCO}_2$  were observed. For this reason, it is unlikely that short-term exposure to hyperbaric environments effects an overall shift in metabolic function. For mixtures containing 43.9 and 98% oxygen at normal pressures, the increase in  $\text{CaO}_2$ , but not in  $\text{CaCO}_2$ , and pH indicates that maximization of hemoglobin oxygen transport potential does not play an important role in the manifestation of increased blood  $\text{CO}_2$  under hyperbaric conditions. In addition, exposure to hyperoxic conditions results in a slight decrease in  $\text{CaCO}_2$  and  $\text{CaN}_2$ , as well as a number of minor variations in acid-base balance parameters.

*Key words:* *cardiovascular system, hypoxia, high altitude, hematology*

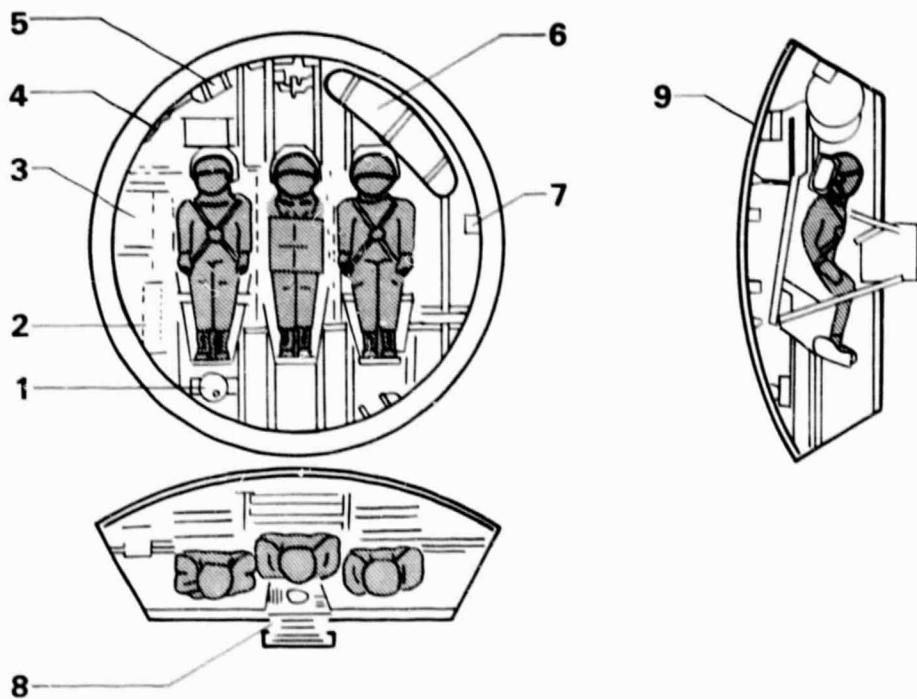
A review of the literature concerning cardiac function at high altitudes was presented by Daniyarov (1979). Emphasis was placed upon hemodynamic changes during hypoxic hypoxia,

alterations in the contractile activity of the heart at high altitude, the dynamics of left ventricular papillary muscle contraction during altitude adaptation, and changes in myocardial structure and metabolism following exposure to altitude-induced hypoxic hypoxia. The results of extensive experimentation on the injection function of the heart during altitude acclimatization were also discussed.

### Personal Protective Equipment

*Key words: emergency, rescue, SERCOS, space capsule*

One possible variant of a system for emergency rescue of cosmonauts from orbital stations (SERCOS) is described by Belonogov and others (1978). The proposed space capsule holds 3 people and can support life for 24 hrs. Diagrammatic representations of the exterior and interior of the capsule and of stages for return to the Earth's surface are pictured below.



#### KEY:

|                                           |                                           |
|-------------------------------------------|-------------------------------------------|
| 1. Pressure block                         | 6. Parachute                              |
| 2. Commutation block                      | 7. Flotation device                       |
| 3. Power supply block                     | 8. Orientation and<br>stabilization block |
| 4. Radio beacon                           | 9. Soft landing engine                    |
| 5. Unit for inflating<br>flotation device |                                           |

## SPACEFLIGHT RESULTS

### Space Medicine and Physiology

#### Cardiovascular System

*Key words: Salyut 5, weightlessness, fatigue, body fluid redistribution*

Degtyarev and colleagues (1980) reported on inflight cardiovascular measurements taken on the crew of Salyut 5 during a 49-day mission. Heart rate, arterial pressure, and systolic time intervals were measured at rest, and peripheral resistance and cardiac output were calculated from these measures. Heart rate changes were variable in this crew, and the flight engineer appeared to show an increase towards the end of the flight. Arterial pressure remained high throughout the flight, particularly in the commander, and the increase was most pronounced during heavy work. Cardiac output also remained elevated in the crewmen throughout the flight. Soviet scientists attribute the poorer inflight physical condition of these crewmen compared to other cosmonauts to fatigue, primarily resulting from lack of sleep, overwork, and a shift in the sleep/wake cycle between the 21st and 30th day of flight. According to these researchers, the crew of the Salyut 5 mission demonstrated cardiovascular signs of marked fatigue and the development of a near-pathological state.

*Key words: Salyut 6, body fluid redistribution, weightlessness, rheography*

Turchaninova and Domracheva (1980) examined central and peripheral hemodynamics in the crews of the 96- and 140-day expeditions aboard Salyut 6 by means of rheograms of the torso, forearms, and legs, and rheoencephalograms of the brain. Three of the four cosmonauts demonstrated an initial increase in stroke volume that subsided after the first week in space. Minute volume tended to exceed preflight levels throughout the flights and decrease postflight. Blood filling in cerebral vessels increased considerably, but returned to normal and even slightly decreased in the crew of the 140-day flight during the last half of the mission. Rheoencephalograms also demonstrated a pronounced asymmetry in cerebral blood filling about halfway through the flights, but this phenomenon was reduced or absent by the end of the mission. Blood volume in leg vessels showed decreases during and after the flights; rheographic measures of the forearm showed either no change or increases inflight. These scientists indicated that the data support the currently accepted theory of cephalad shifts in body fluids during initial exposure to weightlessness.

#### Musculoskeletal System

*Key words: weightlessness, bone metabolism, glycoprotein, Salyut 1*

Prokhorchukov and Leont'yev (1980) studied the effects of prolonged exposure to weightlessness on glycoprotein content of human bone. Osseous bone tissue was obtained at autopsy from the crew of Salyut 1, and compared to control samples from 3 men (20-40 yrs) who died of acute

trauma. Measurement of protein bound hexosamine, hexose, fucose, uronic acid and neuraminic acid, and ketose levels allowed a determination of glycoprotein content in bone tissue. The tissue from the cosmonauts demonstrated no significant differences in glycoprotein content compared to the tissue of controls. The authors attribute these findings to the high level of physical conditioning of the cosmonauts, and to the extensive physical exercise performed inflight.

### Psychology

*Key words: weightlessness, cosmonaut training, human engineering, seminar*

The effect of spaceflight factors on psychological function was discussed in a book edited by Samsonov (1980). Material was drawn largely from reports presented at the first seminar on the psychological problems of spaceflight, organized by the Institute of Psychology of the USSR Academy of Sciences. Four major topics were considered: (1) characterization of the psychological problems of spaceflight, (2) psychological analysis of cosmonaut activity, (3) cosmonaut training, and (4) human engineering. The authors hope that this work will aid in improving the effectiveness and reliability of cosmonauts on future manned missions.

### Space Biology

#### Musculoskeletal System

*Key words: tortoise, weightlessness, bone metabolism, osteoporosis, demineralization*

Stupakov et al. (1979) investigated the effect of spaceflight factors on the tortoise skeleton. Ten tortoises were exposed to flights of either 19, 22, 60, or 90 days, and 20 were specified as control animals. Bending and compression testing, micro-X-ray diffractometry, and histologic analysis were utilized to determine the strength and mineral content of the spongy and compact bone in each of the animals. Osteoporosis was not observed in the compact tissue of any of the experimental animals, even though density and mineral saturation were noted to decrease during the 60- and 90-day flights. Osteoporosis did develop, though, in the spongy bone of tortoises exposed to 60 and 90 days of weightlessness. Spongy bone exhibited a decrease in strength due to the osteoporotic reduction in weight per unit volume resulting from the modification of bone reconstruction processes during spaceflight.

*Key words: weightlessness, artificial gravity, Cosmos 605, Cosmos 782, Cosmos 936, bone metabolism, thyroid C-cells, rat*

Plakhuta-Plakutina (1980) reported on histological studies of thyroid calcitonin secreting cells in rats flown onboard Cosmos 605 (22 days), Cosmos 782 (19.5 days), and Cosmos 936 (18.5 days). The Cosmos 782 and 936 flights in particular afforded the opportunity of observing changes in thyroid morphology immediately after the flight since some of the rats were sacrificed

within hours after landing. The thyroids from these rats demonstrated decreases in both the number and volume of C-cells, compared to both synchronous and vivarium ground-based control animals, suggesting a decrease in C-cell activity. Other morphological measures also pointed towards this conclusion; for example, these animals showed a decrease in the height of the follicular epithelium, consolidation of colloid, and an absence of resorption vacuoles. In rats sacrificed 2 days after landing, histological measures suggested an increase in thyroid functional activity, including an increase in the size and number of C-cells. The thyroid cells apparently return to normal within 25-27 days after flight. The thyroids of the rats exposed to artificial gravity onboard Cosmos 936 were not different from vivarium controls, indicating that weightlessness is the primary variable associated with the morphological changes in the thyroid. These researchers conclude that thyroid C-cell activity is transiently decreased by exposure to weightlessness, thereby lowering the level of calcitonin and adversely affecting the release of calcium from bone tissue.

### **Metabolism**

*Key words: rat, Cosmos 936, weightlessness, artificial gravity, fluid-electrolyte metabolism, renal function, kidney*

Il'in et al. (1980) examined the effects of weightlessness and artificial gravity (AG) on renal function. Five rats were exposed to 0 G and five to AG during the 18.5-day flight of Cosmos 936. Results were obtained via water and potassium load testing and electrolytic analysis of various portions of the kidney following microdissection. More pronounced changes in fluid-electrolyte metabolism were observed in the kidneys of the rats exposed to 0 G. Increased sodium excretion during water load testing and increased potassium excretion during potassium load testing were noted. In addition, electrolytic analysis revealed decreased potassium levels in the wet cortical and medullary tissue in both groups, apparently due to increased tissue hydration. Microdissection of the superficial, intracortical, and juxtamedullary nephrons disclosed no structural abnormalities resulting from exposure to 0 G or AG aboard Cosmos 936.

*Key words: weightlessness, rat, artificial gravity, Cosmos 936, musculoskeletal system, pulmonary system, vestibular system, respiration, fluid-electrolyte metabolism*

A discussion of the metabolic changes associated with weightlessness and artificial gravity (AG) during the flight of Cosmos 936 was presented by Gurovskii et al. (1980). Twenty male rats were exposed to the normal weightless environment of the satellite, and ten were placed in centrifuges to simulate AG of 1 G. Motor activity in rats exposed to the normal satellite environment was observed to be higher and body temperature significantly lower than that of the centrifuged rats. In addition, postflight examination revealed disturbances in gas exchange, electrolyte metabolism, and postural equilibrium; muscular atrophy; bone degeneration; increased sarcoplasmic protein content; and decreased myocardial myosin ATPase activity as a result of exposure to weightlessness. The centrifuged animals exhibited only vestibular and bone metabolism dysfunctions. These scientists conclude that AG is an effective countermeasure against the more serious adverse effects of prolonged weightlessness.

**Key words:** *weightlessness, hypokinesia, Cosmos 782, lipid metabolism, rat, carbohydrate metabolism*

Makho et al. (1980) studied the effect of spaceflight factors on metabolism in the rat via data obtained from the *Cosmos 782* (19.5 days) biosatellite project. Hepatic enzyme activity and lipid levels, and plasma corticosterone levels, were monitored in flight and in synchronous and vivarium control groups. Assays of enzyme activity were performed 6-10 hrs and 26 days postflight. A minor increase in the activities of fructose diphosphatase and phosphoenolpyruvate, and a decrease in glucose-6-phosphatase activity, were observed in the flight and synchronous control groups. This suggested an increase in the rate of gluconeogenesis, with the funneling of de novo synthesized glucose toward glycogen synthesis. In addition, lipogenic enzyme (malate dehydrogenase and ATP citrate lyase) activity was abnormally low (indicating inhibition of fatty acid biosynthesis), and tyrosine aminotransferase and tryptophan pyrolase activity was quite high in the flight and synchronous control animals 6-10 hrs postflight. Enzyme activity returned to normal levels by 26 days postflight in all cases. The researchers concluded that the increase in blood glucose and corticosterone levels, as well as the change in hepatic enzyme activity, should be attributed to the stress induced by hypokinesia rather than to exposure to weightlessness.

#### **Radiation Effects and Protection**

**Key words:** *Apollo, Soyuz, Salyut 6, Cosmos 936, seminar, COSPAR, HZE particles, chromosomal aberrations*

A brief review of the developments in radiation biology discussed at the XXI session of COSPAR, held May-June 1978 at Innsbruck, was presented by Yurov (1979). Emphasis was placed upon experimental results obtained from Apollo, Salyut 6, Soyuz, and *Cosmos 936* missions. Of particular concern were the significant increases in chromosomal aberration frequency induced by exposure to heavy charged particles.

#### **Exobiology**

**Key words:** *Venus, atmosphere, joint Russian-American*

Highlights of the 1978 Russian and American explorations of Venus were presented by Ksanfomalti (1979). Interest focused upon diurnal variations in surface pressure, temperature, composition, and mass of the Venusian atmosphere.

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